

Distribution of *Placostylus* Land Snails in Northernmost New Zealand

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This paper deals exclusively with living and extinct colonies of the large land snail *Placostylus ambagiosus* Suter.

The writer now recognises ten subspecies, including the typical one, and of this number six are here described as new. Of the ten subspecies five are Recent and still living, one has become extinct within Recent times, and the remainder are from consolidated dunes probably of Pleistocene age.

The distributional areas and the mode of occurrence of the fossil subspecies provide the basis of interesting speculation regarding Pleistocene and Post Pleistocene climatic and topographic changes.

The area concerned is the extreme northern block of the North Auckland Peninsula. It extends from Cape Maria van Diemen in the north-west to North Cape to the east, and is bounded to the south by both the tidal arms of Parengarenga Harbour and drifting sand from the Ninety Mile Beach.

This northernmost block is separated from the rest of the North Auckland Peninsula by a great tombolo, largely of drifting and consolidated sand, which extends fifty to sixty miles to the south-east to Ahipara and Awanui. The tombolo is flanked on the western side by the Ninety Mile Beach and on the eastern side by Great Exhibition Bay and Rangaunu Bay. These eastern bays are separated by high country around Mt. Camel, Houhora.

It is evident that at a not very remote time the northernmost block, the Mt. Camel area, and several smaller rocky outcrops, were islands lying off the remainder of the North Auckland Peninsula, and were comparable with the present isolation of the Three Kings group in respect to the mainland.

Several smaller tombolos indicate that the North Cape plateau was formerly an island, and in the west three contiguous small areas were separated from the main block by narrow waterways similar to that which now severs Cape Maria van Diemen Island from the main block. The formation of these small islands was evidently brought about by a considerable negative movement of the land (see Bartrum and Turner, 1928, Trans. N.Z. Inst. 59, p. 105).

The following restricted land molluscs with their southern equivalents point to long isolation of the northernmost block from the rest of the North Auckland Peninsula:—

Northernmost Block.

Peninsula South of Awanui.

<i>Paryphanta watti</i> Powell, 1946	}	<i>P. bushyi</i> (Gray, 1840)
<i>Rhytida duplicata</i> (Suter, 1904)		<i>R. dunniac</i> (Gray, 1840)
<i>Rhytida duplicata vivens</i> Powell, 1946	}	<i>A. dimorphus</i> (Pfeiffer, 1853)
<i>Allodiscus</i> n. sp.		<i>P. hongii</i> (Lesson, 1830)
<i>Placostylus ambagiosus</i> Suter, 1906		

The following is a belated attempt to piece together the distributional pattern of the *ambagiosus* group. Probably no other sparsely populated area in New Zealand has been subjected to such intensive burning, firstly by the Kauri Gum diggers and latterly by the younger Maoris, who still wantonly burn off large areas for no apparent reason. Except for a few isolated patches on high country, practically the whole of the area is now devoid of original forest cover.

The Maungapiko colony was greatly depleted by fire in February, 1946, only a few days before its discovery. The sand dunes of the northern coast at Cape Maria van Diemen, Spirits Bay and Tom Bowling Bay and Waikuku Beach on the east coast are strewn with vast numbers of bleached shells, but these colonies have been destroyed by natural causes. Increasing aridity since the Pleistocene has resulted in the dying out of all that coastal forest which formely grew upon sand.

The fact that sand will support stunted forest if the climate is sufficiently moist is demonstrated at Mason's Beach on the west coast of Stewart Island.

A further factor to be considered is that *Placostylus* never penetrates far inland, and since climatic changes have been more destructive to coastal vegetation than to inland areas, the present discontinuity of the *Placostylus* colonies is accounted for. This segregation of snail colonies into restricted areas is a prime factor in the evolution of new forms by isolation.

The natural causes that have brought about the differentiation of subspecific forms of *ambagiosus* are thus shown to be isolation of stock on small islands formed by a negative movement of the land, and increasing aridity since the Pleistocene. The human factor for historic times probably does not apply, since it has been merely destructive and sufficient time has not elapsed to affect colonies artificially segregated by fires.

On the other hand, pre-European influences cannot be ignored in respect to *Placostylus* populations, since many of the existing colonies are on headlands once occupied by Maoris. A significant fact is that the chief food plant of these snails, the karaka (*Corynocarpus laevigata*), was cultivated by the Maoris for food, and remains of these plantations are a conspicuous feature of most coastal pa sites north of Auckland.

That entirely natural segregation of *Placostylus* occurred prior to the advent of the Maori is shown herein by the geographically isolated subspecies found in consolidated dune deposits of presumed Pleistocene age.

Of the ten subspecific populations here described, *hinemoa*, *worthyi*, *priscus*, *lesleyae*, *spiritus* and *watti* are presumed to have developed in

situ free from human influence. Of the remainder, *ambagiosus* typical is obviously the recent insular descendant of *hincmoa*, and *annectens*, by its occupation of an area considerably larger than a Maori pa site (Unuwhao) within that area, would seem to be natural also, particularly as this subspecies does not show a dependence upon karaka, but is found associated with the generally distributed mahoe (*Melicytus ramiflorus*). The only subspecies that could owe their present location to Maori influence are *consobrinus*, which seems to have lived in historic times, and the still living *keenorum*. These populations could have resulted from stock intentionally or accidentally transported by the Maoris from nearby areas with karaka and flax plants, but this is unlikely since neither colony appears incongruous to its area.

The writer considers that at most the induced karaka plantations of the Maoris, so far as the northernmost block is concerned, merely gave a numerical impetus to *Placostylus* populations already naturally located. On the other hand, a number of colonies of *Placostylus hongii* on islands off the North Auckland east coast appear very definitely to be the result of Maori transportation.

Regarding the dune deposits of the northernmost block, it has often been stated that the *Placostylus* remains are concentrations from Maori cooking sites. The fact remains that most of the shells are entire and none show charring. Also an extinct snail, *Rhytida duplicata* Suter, 1904, and moa remains, often occur with the *Placostylus*.

Undoubtedly there is abundant evidence of Maori occupation on the dunes where the snail remains occur, but the apparent association is the result of a peculiarity of drifting dunes—the telescoping of prior stratification. The fine textured sand moves away by wind action, leaving all heavy objects in a surface layer.

The formation of the Waikuku Flat tombolo is of interest, for it enabled the subsequent spread of a subspecies which had originated through isolation on the North Cape block. However, the time factor coupled with increasing aridity did not allow this subspecies to spread beyond the tombolo to the main block.

In the Cape Maria van Diemen area at least two former islands are now linked by tombolos, but these have formed subsequent to the extinction of the snail colonies, which are found clear cut in situ with areas of sand without fossil snails occurring between.

SPECIFIC CHARACTERS.

1. Coloration. The Cape Maria Island *ambagiosus* has a chestnut-brown epidermis, with a white subsutural band up to 1.5 mm. in width and a salmon-orange apertural callus.

The mainland living forms have a very dark reddish-brown epidermis with a narrow white subsutural band of 0.5 to 1.0 mm. in width, and a deep red to reddish-brown apertural callus.

Apertural colour still remaining in the extinct *consobrinus* indicates that it belonged to the dark reddish-brown series.

2. Processes on the apertural callus. There are five tubercles or thickened processes in full development. (See Powell, 1938, Rec.,

Auck. Inst. Mus. 2 (3), p. 144.) No. 1 is a tubercle high on the outer lip, No. 2 a median tubercle with lateral extensions on outer lip, No. 3 a basal tubercle, No. 4 a thickened columellar fold and No. 5 a parietal tubercle.

In the following table the relative development of the apertural processes in the forms under review is given. 0 is absent, 1 weak, 2 moderate, and 3 strong.

Apertural processes	1.	2.	3.	4.	5.
<i>ambagiosus</i>	2	2	3	1	1
<i>hinemoa</i>	2	1	3	1	2
<i>worthyi</i>	1	1	3	0	0
<i>consobrinus</i>	0	0	3	3	3
<i>priscus</i>	3	3	3	3	0
<i>lesleyae</i>	1	0	1	3	0
<i>spiritus</i>	2	2	3	1	0
<i>keenorum</i>	3	3	3	3	3
<i>annectens</i>	3	3	3	3	3
<i>watti</i>	3	3	3	3	3

THE EGG.

The eggs, which are thin-shelled, white, with a buff-coloured cuticle, are deposited under leaf mould in cylindrical depressions of about one inch in diameter, and the same in depth. At Unuwahao (*annectens*) the nests contained from 15 to 18 eggs.

Examples of *annectens* kept in captivity by Mrs. I. Worthy, of Patumahoe, laid on 5th November, 1946, and hatched on 11th February, 1947, a period of incubation of 93 days.

The tables of dimensions of eggs given below indicate that there is considerable individual variation in size and proportions. However, the results do show that *ambagiosus* typical produces a long narrow egg and *ambagiosus annectens* a constantly larger and more globose egg.

Species.	Length.	Diameter.	Av. Dimensions (in mm.)
<i>hongii</i> (Poor Knights Is.)	6.00	5.00	
	6.00	5.00	
	6.00	5.10	
	5.60	4.70	
	5.60	4.50	5.84 x 4.86
<i>ambagiosus ambagiosus</i>	6.75	4.90	
	6.75	5.00	
	6.10	5.00	
	6.00	4.70	
	5.75	4.90	6.27 x 4.9

Species.	Length.	Diameter.	Av. Dimensions (in mm.)
<i>ambagiosus keenorum</i>	6.80	5.10	
(West side)	6.75	5.30	
	6.50	5.10	
	6.50	5.00	
	6.20	5.00	6.55 x 5.10
(East side)	6.10	5.00	
	6.10	5.10	
	6.00	5.30	
	6.00	4.90	
	5.75	5.40	5.99 x 5.14
<i>ambagiosus spiritus</i>	6.40	5.00	
	6.25	5.00	
<i>ambagiosus annectens</i>	7.30	5.75	
	6.90	5.70	
	6.60	5.75	
	6.40	5.80	
	6.40	5.30	6.72 x 5.66

THE EMBRYONIC SHELL.

There is scarcely any difference between the embryonic shell of *ambagiosus* typical and that of *ambagiosus annectens* apart from the relative larger size of the latter, but they both differ from that of *hongii* in details of initial coiling and subsequent sculpture.

The radial ribbing of the first post-nuclear whorl in *hongii* is evenly sigmoid, but in *ambagiosus* it changes abruptly in inclination six times, so that the ribs have a zig-zag recurrent trend. The initial coiling in *hongii* shows the tip to be gently incurved and slightly immersed in a shallow pit, but in *ambagiosus* the initial whorl is much more deeply immersed and it bends inward at so sharp an angle that a raised narrow shoulder projects to form the actual tip above a deep narrow cleft. On the later whorls of the protoconch the ribbing tends to become evenly arcuate in both species. The radials stop abruptly at the periphery except for faint radial growth lines. The base is devoid of spiral sculpture in *hongii*, but has faint punctate spiral lines in both *ambagiosus* and *ambagiosus annectens*.

KEY TO SUBSPECIES.

Diagrammatic representations of the shells are introduced in place of the conventional descriptive key (see folder plate). These show relative dimensions, adult size range, height of aperture, spire angle and the apertural-process formula. Visual comparison is afforded and, since the diagrams are reproduced actual size, specimens may be placed upon the diagrams for determining proportion and spire angle.

Note: Overall dimensions, especially diameter, are deceptive to the eye, appearing greater than they actually are, so place the shell with the axis vertical and in parallel plane with the diagram. The aperture, also, should be in parallel plane. Use a right-angled set-square to line up the shell with the diagram. The heavy continuous lined rectangles represent average height and diameter and the larger and smaller dotted rectangles the greatest and least dimensions respectively. The cross bar denotes average height of the peristome. Similarly, the average spire angle is the heavy continuous line, and greatest and least angles are the additional dotted lines.

In matching shells for spire angle take the profile of the post-nuclear whorls, excluding the protoconch, which on account of its bluntly conic shape shows a much broader angle than for the rest of the spire.

The circles of figures refer to the relative strengths of the five apertural processes in the order of 0-3 (see preceding table). In using the diagrammatic key the suggested procedure is: (1) match approximately for dimensions, (2) determine spire angle, (3) check apertural processes.

The tables are compilations of the measurements of ten specimens, so individual variation must be allowed for—an example showing maximum diameter is not likely to have maximum height also.

TABLES OF DIMENSIONS.

The following tables record the individual characteristics of fourteen colonies of snails. Ten examples were chosen from each lot with the exception of two localities where less than that number were collected. For most localities 50-100 examples were available. The only selective action was to discard malformations and to ensure that both the largest and the smallest adult for each locality was included; the rest were taken at random.

Column (1) gives the height, (2) the diameter, (3) the outside height of the apertural callus from the suture to the basal lip, (4) the spire ratio, being the total height divided by the apertural callus height, and (5) is the angle of the spire. The two initial whorls are ignored in estimating this angle.

1. *ambagiosus ambagiosus* Suter, 1946.

Ht.	Diam.	Ap. ht.	Sp. ratio.	Sp. ang.
77.75	33.00	34.50	2.251	45°
77.00	32.00	35.00	2.200	50°
75.00	31.50	34.00	2.205	50°
75.00	32.50	36.00	2.083	50°
74.00	32.00	36.00	2.055	50°
72.50	33.50	37.00	1.959	50°
72.00	31.50	35.00	2.057	50°
70.50	30.00	33.50	2.104	49°
70.50	31.00	33.00	2.136	49°
69.50	31.00	32.50	2.138	50°

Ht.	Diam.	Ap. ht.	Sp. ratio.	Sp. ang.
2. <i>ambagiosus hinemoa</i> n. subsp.				
82.00	36.00	39.50	2.076	50°
80.00	36.00	40.00	2.000	50°
78.00	36.00	37.50	2.080	53°
78.00	36.00	37.00	2.108	57°
75.50	37.50	38.00	1.986	58°
74.00	36.00	38.00	1.947	62°
74.00	35.00	37.00	2.000	60°
71.75	34.00	34.50	2.079	54°
69.00	31.00	32.50	2.123	50°
68.50	31.50	33.00	2.057	53°
3. <i>ambagiosus worthyi</i> n. subsp.				
75.50	34.50	38.00	1.961	54°
70.50	31.00	33.00	2.136	49°
69.00	33.50	36.00	1.916	51°
68.50	30.00	32.50	2.107	50°
68.00	27.50	30.00	2.266	50°
64.00	28.00	29.00	2.206	50°
63.50	30.00	31.50	2.015	50°
62.00	27.50	29.00	2.137	50°
61.50	26.00	27.50	2.236	50°
57.50	26.00	28.00	2.053	53°
4. <i>ambagiosus consobrinus</i> Powell, 1938.				
86.00	37.00	37.00	2.324	46°
81.00	35.00	35.00	2.314	47°
80.00	34.50	34.50	2.318	46°
79.50	34.00	34.00	2.338	44°
79.00	35.00	35.00	2.257	45°
79.00	35.00	35.00	2.257	47°
76.50	34.50	34.50	2.217	46°
73.50	32.50	32.50	2.567	47°
71.00	32.00	32.00	2.218	44°
70.50	30.50	30.50	2.311	46°
5. <i>ambagiosus priscus</i> Powell, 1938.				
81.50	33.00	37.00	2.202	49°
77.00	31.00	37.00	2.081	44°
76.50	31.00	36.00	2.125	45°
75.50	31.00	36.50	2.068	47°
75.00	31.50	36.00	2.083	49°
75.00	31.00	35.00	2.142	48°
75.00	32.00	35.00	2.142	47°
74.00	29.50	34.00	2.176	48°
74.00	29.00	35.00	2.114	46°
74.00	32.00	36.00	2.055	47°

Ht.	Diam.	Ap. ht.	Sp. ratio.	Sp. ang.
6. <i>ambagiosus lesleyae</i> n. subsp.				
83.00	35.00	29.00	2.128	49°
80.00	36.00	39.00	2.051	50°
79.00	32.50	37.00	2.135	49°
77.00	33.00	38.00	2.333	50°
75.00	32.50	35.50	2.112	50°
75.00	33.00	35.50	2.112	51°
74.50	33.00	36.00	2.069	50°
74.00	31.00	34.50	2.113	49°
73.50	32.00	35.00	2.100	51°
72.50	32.50	37.00	1.959	51°
7. <i>ambagiosus spiritus</i> n. subsp.				
75.00	29.50	33.00	2.272	48°
75.00	32.50	35.50	2.112	50°
72.75	31.00	34.50	2.108	50°
70.00	29.00	33.00	2.121	46°
70.00	30.00	32.50	2.153	47°
68.50	30.00	32.00	2.140	50°
68.00	30.50	31.00	2.193	47°
68.00	29.00	31.50	2.158	47°
66.00	28.50	31.00	2.129	48°
65.00	28.50	31.00	2.096	46°
8. <i>ambagiosus kecnorum</i> n. subsp. (Maungapiko, west side).				
84.00	35.00	39.50	2.126	42°
83.30	35.00	41.00	2.031	44°
79.00	34.00	37.50	2.106	45°
76.50	33.00	38.50	1.987	46°
76.00	31.00	36.00	2.111	41°
75.75	31.00	34.50	2.195	42°
75.50	32.00	35.50	2.126	46°
75.00	30.00	35.00	2.140	40°
71.75	30.50	35.50	2.021	42°
70.25	28.00	34.00	2.066	40°
(Maungapiko, east side)				
81.00	32.00	37.00	2.189	40°
80.25	32.50	38.00	2.112	40°
80.00	33.00	38.00	2.105	39°
79.50	32.00	36.50	2.178	40°
79.00	31.00	37.00	2.138	35°
78.50	30.50	37.00	2.122	40°
77.25	29.50	35.00	2.207	36°
77.00	33.00	38.00	2.026	40°
77.00	31.00	35.50	2.169	40°
76.50	31.00	36.00	2.125	39°

	Ht.	Diam.	Ap. ht.	Sp. ratio.	Sp. ang.
9.	<i>ambagiosus annectens</i> Powell, 1938. (Unuwahao; type loc.)				
	95.00	40.00	46.00	2.065	50°
	94.00	40.00	46.00	2.043	49°
	94.00	41.00	45.00	2.088	50°
	90.00	39.00	45.00	2.000	50°
	90.00	37.50	43.00	2.093	49°
	89.00	38.00	43.00	2.069	51°
	88.00	38.50	41.00	2.148	49°
	87.00	39.00	44.00	1.977	50°
	86.75	40.00	45.00	1.927	50°
	86.50	36.00	40.00	2.162	50°
	(Unuwahao; coast ridge)				
	88.75	38.50	42.00	2.113	49°
	88.50	37.00	41.00	2.158	49°
	88.00	37.00	41.00	2.146	49°
	88.00	37.50	41.50	2.120	50°
	87.00	38.00	42.00	2.071	51°
	86.76	38.00	40.50	2.142	49°
	82.25	37.00	40.00	2.056	51°
10.	<i>ambagiosus watti</i> n. subsp. (Recent. Type loc.)				
	86.00	39.00	43.00	2.000	51°
	83.00	39.00	43.00	1.930	51°
	81.00	36.50	39.00	2.076	50°
	80.50	39.00	40.00	2.012	51°
	80.25	37.50	42.00	1.911	51°
	79.00	34.50	38.00	2.078	50°
	77.50	35.00	38.50	2.013	50°
	76.00	34.00	38.00	2.000	51°
	(Subrecent, Tom Bowling Bay)				
	83.50	35.00	40.00	2.087	50°
	81.00	33.50	36.50	2.219	51°
	80.50	35.00	39.50	2.038	50°
	80.00	35.00	37.50	2.133	50°
	80.00	34.50	37.00	2.162	51°
	79.00	35.00	38.50	2.052	50°
	78.75	35.00	38.50	2.045	51°
	77.50	32.50	36.00	2.152	50°
	77.00	33.00	38.00	2.026	49°
	71.00	32.00	34.00	2.088	50°
	(Subrecent, Waikuku Beach)				
	81.00	35.00	39.00	2.077	50°
	81.00	32.00	37.00	2.189	48°
	81.00	35.50	40.00	2.025	50°
	79.50	33.00	36.00	2.208	49°
	77.50	33.00	36.75	2.108	50°
	76.50	32.50	36.00	2.125	50°
	76.25	32.50	37.50	2.033	52°
	76.00	35.00	39.00	1.948	55°
	75.00	32.50	37.00	2.027	49°
	74.00	33.00	38.00	2.242	54°

PLACOSTYLUS Beck, 1837.**MAORISTYLUS Haas, 1935.**Type (o.d.): *BULIMUS SHONGHII* Lesson.**Placostylus (Maoristylus) ambagiosus Suter, 1906.**1906 *Placostylus hongii ambagiosus* Suter, Journ. de Conch. Paris, 54, p. 253, Pl. 8.1913 *Placostylus hongii ambagiosus* Suter, Man. N.Z. Moll., p. 768; not Suter, 1915, Atlas, Pl. 48, f. 15.1938 *Placostylus ambagiosus Powell*, Rec. Auck. Inst. Mus. 1 (3), p. 147, Pl. 34, f. 1.

Type locality: Cape Maria van Diemen (Island).

1. Placostylus (Maoristylus) ambagiosus ambagiosus Suter, 1906. Pl. 20, figs. 1-3.*Dimensions:*Average ht. 73.37 mm., diam. 31.80 mm., ap. ht. 34.65 mm., sp. ang. 49.3°
Greatest ht. 77.75 mm., diam. 33.50 mm., ap. ht. 37.00 mm., sp. ang. 50°
Least ht. 69.50 mm., diam. 30.00 mm., ap. ht. 32.50 mm., sp. ang. 45°*Apertural processes:* 2 2 3 1 1*Coloration.*—Epidermis: Ochraceous-tawny and russet to Mars brown, with a wide subsutural white margining.
Aperture: Salmon-orange.**Locality:* Cape Maria van Diemen Island, Recent (type). Small colonies still exist around the roots of flax (*Phormium*) on the south-west cliff face; Mr. F. Young, May, 1934. The island is of 411 feet elevation and is sparsely clothed with flax (*Phormium*) and stunted trees and scrub. It is separated from the mainland by a deep-water channel of $\frac{3}{4}$ mile in width.*Remarks:* The typical species is restricted to the island and is distinguished from all the mainland subspecies by its lighter brown epidermis with a 1.5 mm. white subsutural margining, and salmon-orange apertural callus.*Holotype:* In the H. Suter collection, N.Z. Geological Survey, Wellington. 74 mm. x 33 mm.**2. Placostylus (Maoristylus) ambagiosus hinemoa, n. subsp. Pl. 20, figs 4-6.***Dimensions:*Average ht. 75.07 mm., diam. 34.85 mm., ap. ht. 36.70 mm., sp. ang. 54.7°
Greatest ht. 82.00 mm., diam. 37.50 mm., ap. ht. 40.00 mm., sp. ang. 62°
Least ht. 68.50 mm., diam. 31.00 mm., ap. ht. 32.50 mm., sp. ang. 50°*Apertural processes:* 2 1 3 1 2*Locality:* Cape Maria van Diemen Island in consolidated sand-dunes presumably of Pleistocene age. Captain J. Bollons, 1924, and Mr. F. Young, 1934.

* All colour references are from Ridgway, 1912, Colour Standards and Colour Nomenclature.

Remarks: Compared with the typical subspecies, *hinemoa* is of much heavier build, is proportionately broader and has a wider spire angle. The subspecies is named in memory of the former Government steamer and lighthouse tender "Hinemoa."

Holotype: In the writer's collection, Auckland Museum. 75.7 mm. x 37.5 mm.

3. ***Placostylus (Maoristylus) ambagiosus worthyi*** n. subsp.
Pl. 20, figs. 7-9.

Dimensions:

Average ht. 66.00 mm., diam. 29.40 mm., ap. ht. 31.45 mm., sp. ang. 50.7°
Greatest ht. 75.50 mm., diam. 34.50 mm., ap. ht. 38.00 mm., sp. ang. 54°
Least ht. 57.50 mm., diam. 26.00 mm., ap. ht. 27.50 mm., sp. ang. 49°

Apertural processes: 1 1 3 0 0

Coloration.—Apertural colour in freshly excavated examples is not sufficiently intense to determine if the original colour linked them with the salmon-orange typical species of the island or the dark-red mainland series.

Locality: In consolidated sand-dunes, presumably of Pleistocene age, on the north-eastern side of the extreme north-western Cape Maria van Diemen mainland. Large numbers of weathered shells are to be found loose in the superimposed Recent drifting dunes. Examples dug from the consolidated dunes still exhibit traces of apertural colour. The visible area occupied by this subspecies is about one acre. Messrs. E. T. B. Worthy, A. C. O'Connor, and A. W. B. Powell, February, 1946.

Remarks: This subspecies is the smallest of the series. In shape it more closely resembles the typical Recent species than its contemporary, the island fossil subspecies *hinemoa*. Apart from small size, the main differentiating feature of *worthyi* is the poorly developed apertural processes, for only the basal tubercle 3, is prominent. Even in obviously senile examples these characters remain constant.

The extreme north-western headland, where these snails, and the following form, *consobrinus*, occur, is obviously a former island now tied to the mainland by a tombolo. A belt of drifting sand from half to three-quarters of a mile in width, which is devoid of fossil snails, indicates the prior existence of a waterway similar to the one which now separates the north-western headland from Cape Maria van Diemen Island. This former waterway was obviously the factor which operated in the segregation of *worthyi* from *priscus*.

Holotype: In Auckland Museum. 63.25 mm. x 29.50 mm.

4. ***Placostylus (Maoristylus) ambagiosus consobrinus*** Powell,
1938. Pl. 20, figs. 10-12.

1938 *Placostylus ambagiosus consobrinus* Powell. Rec. Auck. Inst. Mus. 1 (3), p. 149, Pl. 34, f. 7, 8.

Dimensions:

Average ht. 77.60 mm., diam. 34.00 mm., ap. ht. 34.00 mm., sp. ang. 45.8°
Greatest ht. 86.00 mm., diam. 37.00 mm., ap. ht. 37.00 mm., sp. ang. 47°
Least ht. 70.50 mm., diam. 30.50 mm., ap. ht. 30.50 mm., sp. ang. 44°

Apertural processes: 0 0 3 3 3

Coloration.—Most examples have strong apertural colour indicating the subspecies as one of the mainland reddish-brown series.

Locality: In Recent loose sand-dunes on the north-eastern side of the extreme north-western Cape Maria van Deimen mainland. A. W. B. Powell, February, 1932, and February, 1946.

Remarks: This is the most distinctive of all the subspecies. It is readily recognised by the relatively small aperture and the invariable fact that the height of the aperture equals the major diameter of the shell. In all other forms the apertural height is greater than the diameter of the shell. The apertural processes are of distinctive arrangement also, with the first two tubercles obsolete and numbers 3, 4 and 5 well developed.

It seems likely that this form became extinct within comparatively Recent times, for it is found associated with the outermost fringe of flax at the junction between the rough pasture of the headland and the drifting sand.

On the occasion of the 1946 visit very few *consobrinus* were to be found, and indications are that the colony never was extensive.

Holotype: In Auckland Museum. 79 mm. x 35 mm.

5. **Placostylus (Maoristylus) ambagiosus priscus** Powell, 1938.
Pl. 21, figs. 1-3.

1938 *Placostylus ambagiosus priscus* Powell, Rec. Auck. Inst. Mus. 1 (3), p. 149, Pl. 34, f. 9, 10.

Dimensions:

Average ht. 75.75 mm., diam. 31.10 mm., ap. ht. 35.75 mm., sp. ang. 47°

Greatest ht. 81.50 mm., diam. 33.00 mm., ap. ht. 37.00 mm., sp. ang. 49°

Least ht. 74.00 mm., diam. 29.00 mm., ap. ht. 34.00 mm., sp. ang. 44°

Apertural processes: 3 3 3 3 0

Locality: In consolidated sand-dunes of presumed Pleistocene age commencing on rising ground about three-quarters of a mile east of the extreme north-western headland and bearing north-east to the highest land in the vicinity—a hill of 700 feet which is capped with flax, toetoe, and stunted pohutukawa. From this hill further exposures of these snails either in situ or derived in recent drift-sand occur both to the north almost down to sea level and to the east towards Te Werahi Stream and Te Werahi Swamp, which formed, no doubt, the eastern boundary of the colony. A. W. B. Powell, February, 1932, and February, 1946.

Remarks: This subspecies is distinguished by its narrow spire angle, laterally compressed body-whorl, and oblique, long, and comparatively narrow aperture. The apertural processes are all strong with the exception of number five, which is absent.

That the area was once clothed with dense rain forest is shown by the associated fossil land molluscs: *Paryphanta watti*, *Rhytida duplicata*, *Serpho kivi*, *Gerontia cordelia* and *Liarca* n. sp.

Holotype: In Auckland Museum. 77 mm. x 31 mm.

6. **Placostylus (Maoristylus) ambagiosus lesleyae** n. subsp.
Pl. 21, figs. 4-6.

Dimensions:

Average ht. 76.35 mm., diam. 33.05 mm., ap. ht. 36.65 mm., sp. ang. 50°

Greatest ht. 83.00 mm., diam. 36.00 mm., ap. ht. 39.00 mm., sp. ang. 51°

Least ht. 72.00 mm., diam. 31.00 mm., ap. ht. 34.50 mm., sp. ang. 49°

Apertural processes: 1 0 1 3 0

Locality: Taputaputa Bay, east of Cape Te Reinga. Collected by Miss Lesley Keene, April, 1946. The specimens were apparently from recently exposed consolidated dunes underlying Recent drifting dunes. The writer failed to locate any specimens at this locality in February, 1932.

Remarks: On shell proportions this subspecies closely resembles typical *ambagiosus*, but it attains slightly larger size and has distinctive apertural features. No. 3 tubercle, the most persistent one in all the other subspecies, is in *lesleyae* relatively weak and tends, together with numbers 1 and 2, to become obsolete. The most prominent process is No. 4, the thickened columellar fold, which is stronger than in any other subspecies. In fully adult and senile examples the apertural callus becomes uniformly thickened and reflexed at the outer edge.

There is no indication of former distributional extent of this subspecies beyond the type locality.

Holotype: In Auckland Museum. 74.5 mm. x 33.2 mm.

7. *Placostylus (Maoristylus) ambagiosus spiritus* n. subsp.
Pl. 21, figs 7-9.

Dimensions:

Average ht. 69.92 mm., diam. 29.85 mm., ap. ht. 32.50 mm., sp. ang. 47.9°

Greatest ht. 75.00 mm., diam. 32.50 mm., ap. ht. 35.50 mm., sp. ang. 50°

Least ht. 65.00 mm., diam. 28.50 mm., ap. ht. 31.00 mm., sp. ang. 46°

Apertural processes: 2 2 3 1 0

Locality: In loose sand-dunes at Spirits Bay, two to three miles east of Pandora. A. W. B. Powell, February, 1932.

Holotype: In Auckland Museum. 68.7 mm. x 29.5 mm.

Remarks: This is a dwarf form comparable with *worthyi* in size and shape, but having more developed apertural processes, the basal tubercle being particularly strong. It is a near relative to the next subspecies, *keenorum*, from Maungapiko, at the north-eastern end of Spirits Bay.

Since the above was written Mr. R. H. Michie, of Kaitaia located a living colony a short distance west of Pandora. This colony has survived on the stable terrain, but only subfossil examples remain at the type locality on the drifting dunes. The dimensions, spire-angle and apertural processes come within the range for the type series. The coloration and narrow subsutural band are exactly as in the next subspecies, *keenorum*.

A bleached shell showing apertural colour and two fragments were found by the writer in February, 1946, at 800 feet on the eastern side of Kahuronaki (Kahuroa on survey maps), which lies about three miles south of Spirits Bay and between Te Paki and Te Hapua. This form measures 78 mm. x 35 mm, and probably represents still another subspecies. Kahuronaki is one of the few localities in the northernmost block that still carries original forest cover. A further search may result in the finding of living colonies in this vicinity.

8. *Placostylus (Maoristylus) ambagiosus keenorum* n. subsp.
Pl. 22, figs 1-5.

Dimensions (East Side Colony):

Average ht. 78.60 mm., diam. 31.55 mm., ap. ht. 36.80 mm., sp. ang. 38.9°
Greatest ht. 81.00 mm., diam. 33.00 mm., ap. ht. 38.00 mm., sp. ang. 40°
Least ht. 76.50 mm., diam. 29.50 mm., ap. ht. 35.00 mm., sp. ang. 35°

(West Side Colony):

Average ht. 76.70 mm., diam. 31.95 mm., ap. ht. 36.70 mm., sp. ang. 42.8°
Greatest ht. 84.00 mm., diam. 35.00 mm., ap. ht. 41.00 mm., sp. ang. 46°
Least ht. 70.25 mm., diam. 28.00 mm., ap. ht. 34.00 mm., sp. ang. 40°

Apertural processes: 3 3 3 3 3

Coloration.—*Epidermis*: Russet to Mars brown, diffused with dark warm-sepia. White subsutural margining very narrow.
Aperture: Deep red-brown within and light ochraceous-salmon on reflected edge of peristome.

Localities: Two almost continuous colonies on the eastern (type) and western slopes, respectively of Maungapiko, at 50-150 feet, eastern end of Spirits Bay. A. C. O'Connor, E. T. B. Worthy, and the writer, February, 1946.

Remarks: This subspecies is easily recognised by its slender shape, which results in the narrowest spire angle of the group, and an aperture considerably higher than wide. All five apertural processes are fully developed and the coloration is identical with that of the much larger and broader *annectens* from three to four miles to the south-east at 800-900 feet.

The eastern and western colonies respectively exhibit a slight difference in spire angle. Those from the western side have on the whole a slightly greater angle. Considering that the two colonies must have had a continuous distribution around Maungapiko at a comparatively recent date, this difference in spire angle is remarkable. It cannot be explained as the result of isolation, but would seem to be ecological, for those on the east side have warmer conditions and a greater abundance of food (leaves of the karaka tree). More rapid growth could conceivably result in whorl acceleration, although the largest subspecies, *annectens*, from the high forested ridges around Unuwahao, have achieved large size without abnormal acceleration of the whorls. Examples of *hongii* from the Poor Knights Islands kept in captivity made no growth during the winter months. This fact may have a bearing upon the Maungapiko colonies, since those on the warm eastern side compared with those on the cooler western side should have a longer annual period suited to growth.

The colonies are clustered around the roots of fern, *Carex* and amongst flax (*Phormium*) wherever their food tree, the karaka, is present. Unfortunately, an extensive scrub fire in January, 1946, destroyed hundreds of these snails and reduced both colonies to such an extent that it is doubtful if they will long survive.

The figures of juveniles of both *keenorum* and *annectens* (Pl. 17, figs 3 and 8) show the differences in proportions to be even more marked than in adults. An example of *keenorum* (east side) has the peristome just formed at 79.25 mm. in height, whereas this stage obtains in *annectens* at 87.50 mm.

The subspecies is named in recognition of hospitality extended to the writer on several occasions by Mr. and Mrs. L. Keene, of Te Pahi.

Holotype: From Maungapiko, east side, in Auckland Museum. 80.7 mm. x 32.6 mm.

9. *Placostylus (Maoristylus) ambagiosus annectens* Powell, 1938. Pl. 22, figs 6-9.

1938 *Placostylus ambagiosus annectens* Powell, Rec. Auck. Inst. Mus. 2 (3), p. 148, Pl. 34, f. 2-6.

Dimensions:

Average ht. 90.02 mm., diam. 38.90 mm., ap. ht. 43.80 mm., sp. ang. 49.8°
 Greatest ht. 95.00 mm., diam. 41.00 mm., ap. ht. 46.00 mm., sp. ang. 51.0°
 Least ht. 86.50 mm., diam. 36.00 mm., ap. ht. 40.00 mm., sp. ang. 49.0°

Apertural processes: 3 3 3 3 3

Coloration.—Epidermis: Russet to Mars brown, diffused with dark warm-sepia. White subsutural margining very narrow.

Aperture: Deep red-brown within and light ochraceous salmon on reflected edge of peristome.

Localities: Unuwahao, 900 feet, on track between Spirits Bay and Tom Bowling Bay (type); coastal ridge north of type locality and connected with Unuwahao by a horseshoe-shaped narrow ridge, now deforested. A. W. B. Powell, February, 1932, and February, 1946.

Remarks: This is the largest subspecies. In proportions it is nearest to the following subspecies, *watti*, but in coloration it is identical with *kecnorum*. It lives only near the crest of ridges in rain forest at from 700 to 900 feet, and occurs around clumps of *Carex* and under fallen leaves. It is seldom found at more than 30 feet below the crest of a ridge. The chief food plant is mahoe, for karaka is scarce at Unuwahao.

Holotype: In Auckland Museum. 94 mm. x 40 mm.

10. *Placostylus (Maoristylus) ambagiosus watti* n. subsp. Pl. 22, figs. 10-13.

Dimensions:

Recent (type locality):

Average ht. 80.40 mm., diam. 36.81 mm., ap. ht. 40.18 mm., sp. ang. 50.625°
 Greatest ht. 86.00 mm., diam. 39.00 mm., ap. ht. 43.00 mm., sp. ang. 51°
 Least ht. 76.00 mm., diam. 34.00 mm., ap. ht. 38.00 mm., sp. ang. 50°

Subrecent (drifting dunes, Tom Bowling Bay):

Average ht. 78.85 mm., diam. 34.05 mm., ap. ht. 37.55 mm., sp. ang. 50.2°
 Greatest ht. 83.50 mm., diam. 35.00 mm., ap. ht. 40.00 mm., sp. ang. 51°
 Least ht. 71.00 mm., diam. 32.00 mm., ap. ht. 34.00 mm., sp. ang. 49°

Subrecent (drifting dunes, Waikuku):

Average ht. 77.77 mm., diam. 33.40 mm., ap. ht. 37.62 mm., sp. ang. 50.7°
 Greatest ht. 81.00 mm., diam. 35.50 mm., ap. ht. 40.00 mm., sp. ang. 55°
 Least ht. 74.00 mm., diam. 32.00 mm., ap. ht. 36.00 mm., sp. ang. 48°

Apertural processes: 3 3 3 3 3

Coloration.—Epidermis: Antique brown, auburn to bay. White subsutural margining narrow.

Aperture: Mars orange to Sanford's brown within, tinged with deep red-brown towards the apertural processes and fading to light ochraceous salmon on the reflected edge of the peristome.

Localities: Midway between Waikuku Beach and North Cape Lighthouse, 10-30 feet elevation and from 25 to 200 feet back from the boulder-strewn beach, Recent (type). They occur either around *Carex*, under karaka and pohutukawa, or under flax (*Phormium*) within the leaf fall area of individual karaka trees; Tom Bowling Bay, subrecent in loose dunes; Waikuku Beach, subrecent in loose dunes. A. W. B. Powell, December, 1945.

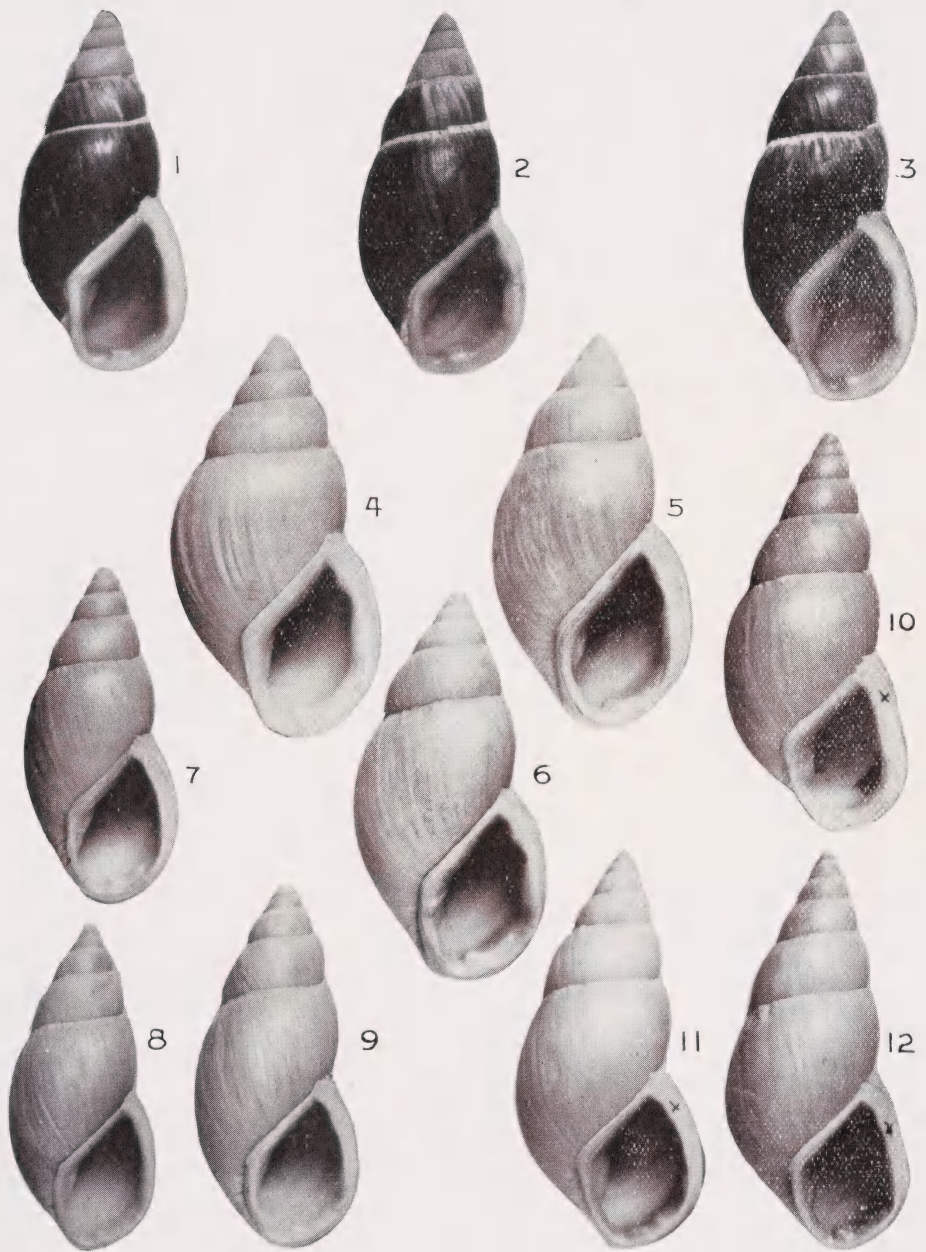
Holotype: In Auckland Museum. 81 mm. x 36 mm.

Remarks: This subspecies is very close to *annectens*, but it is constantly of smaller adult size and the epidermis is paler and more reddish-brown without the diffused dark warm-sepia. It should be noted that the largest examples of *watti* are senile, yet they are smaller than an immature *annectens* with the peristome just formed, that is at 87.50 mm. The North Cape subspecies evidently became differentiated through isolation prior to the linking of that area to the mainland with the formation of a tombolo known as the Waikuku Flat. After the formation of the tombolo, dunes heaped up on the north flank at Tom Bowling Bay and on the eastern side at Waikuku Beach. Both these dune formations are littered with the bleached shells of a *Placostylus* which seems inseparable from *watti*.

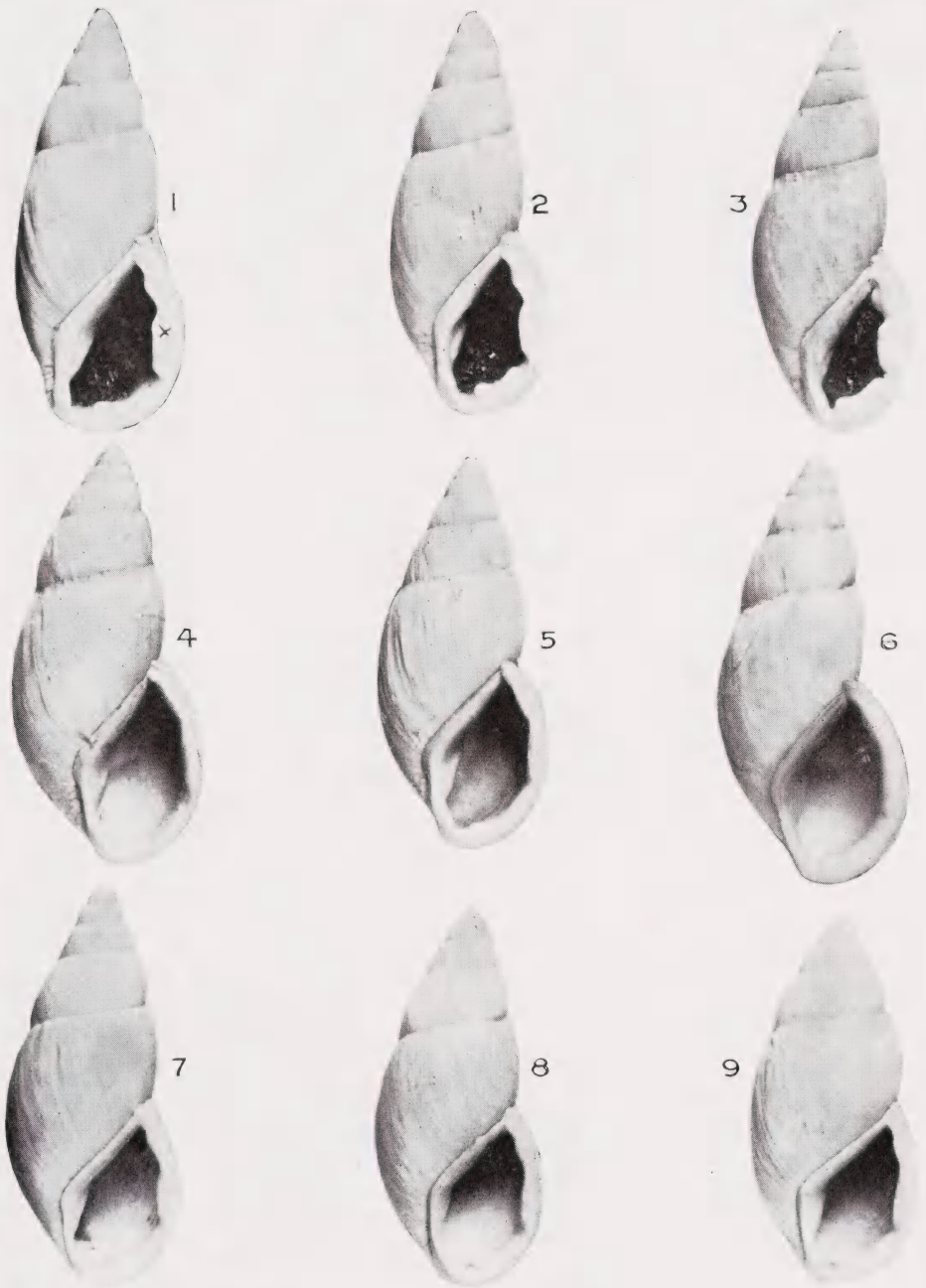
The inferences are that (1) the insular stock on the former "North Cape Block, Island," spread over the tombolo when it was formed, which was probably in post-Pleistocene times. (2) The dunes at the time these snail colonies lived were covered with coastal forest. Although *Placostylus* can live in semi-arid conditions the dunes contain the remains of *Rhytida dunniæ* as well as *Placostylus*, indicating that rather moist conditions then prevailed. (3) The time factor, or more likely increasing dryness, evidently prevented *watti* from joining up with the high-country *annectens* at Unuwahao.

There is very little vegetation remaining on the North Cape block, and it is doubtful if this subspecies will long survive the inroads of fires and the trampling by cattle.

The species is named in honour of Mr. A. H. Watt, of Paua, Parengarenga.

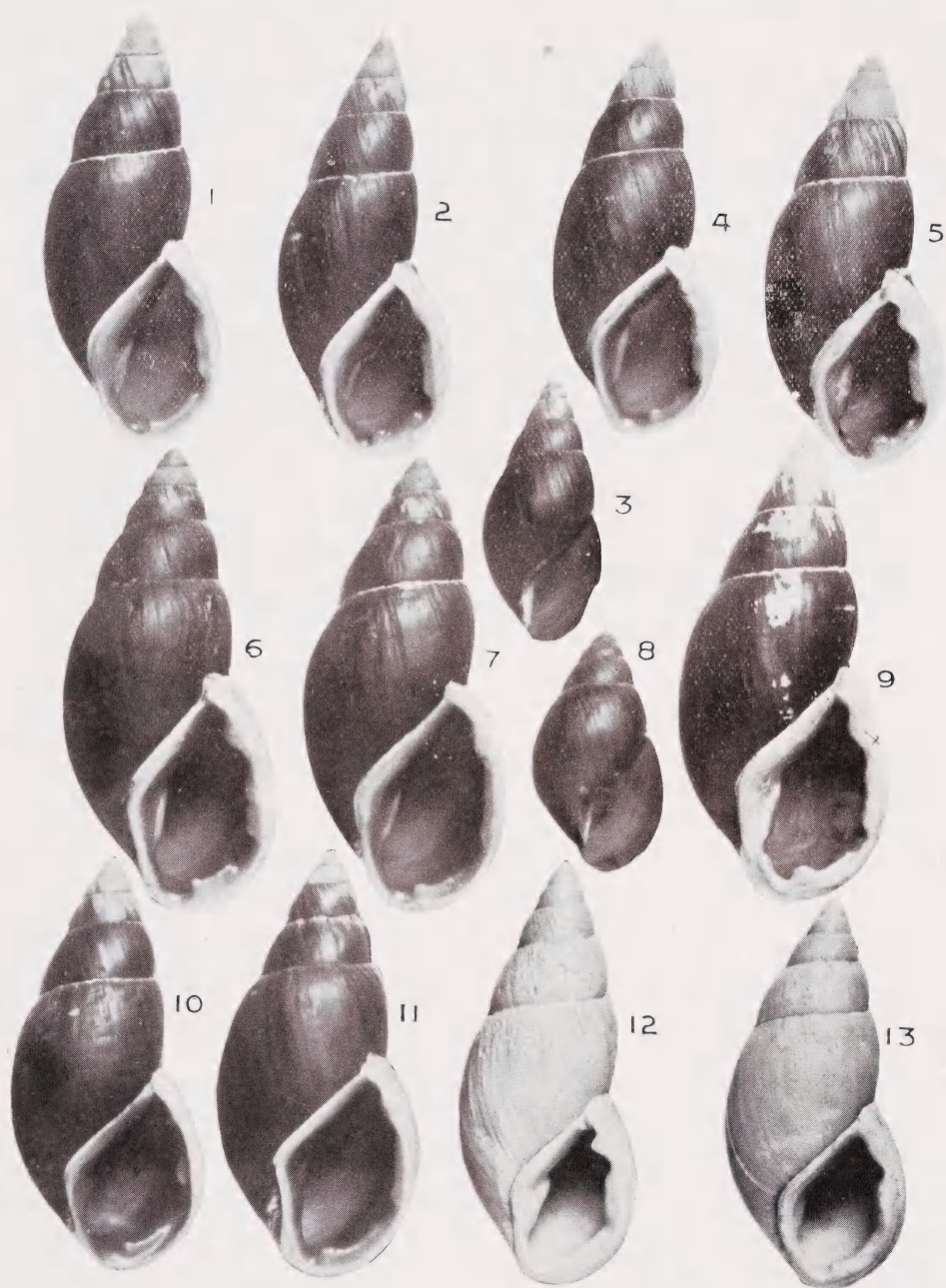


Figs. 1-3. *Placostylus ambagiosus ambagiosus* Suter, 1906.
 Figs. 4-6. *Placostylus ambagiosus hinemoa* n. subsp. Holotype, fig. 4.
 Figs. 7-9. *Placostylus ambagiosus worthyi* n. subsp. Holotype fig. 7.
 Figs. 10-12. *Placostylus ambagiosus consobrinus* Powell, 1938. Holotype, fig. 10.
 (All figures reduced to uniform scale)



Figs. 1-3. *Placostylus ambagiosus priscus* Powell, 1938. Holotype, fig. 1.
 Figs. 4-6. *Placostylus ambagiosus lesleyae* n. subsp. Holotype, fig. 5.
 Figs. 7-9. *Placostylus ambagiosus spiritus* n. subsp. Holotype, fig. 7.

(All figures reduced to uniform scale)



Figs. 1-5. *Placostylus ambagiosus keenorum* n. subsp. Holotype, fig. 1; half-grown example, fig. 3; Maungapiko, west side, figs. 4 and 5.

Figs. 6-9. *Placostylus ambagiosus annectens* Powell, 1938. Holotype, fig. 9; half-grown example, fig. 8.

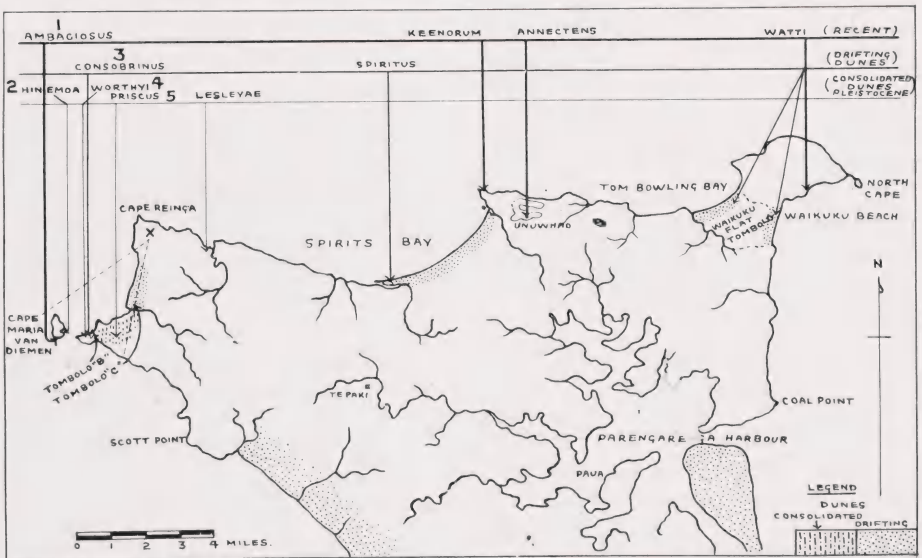
Figs. 10-13. *Placostylus ambagiosus watti* n. subsp. Holotype, fig. 10; Waikuku Beach, fig. 12; Tom Bowling Bay, fig. 13.

(All figures reduced to uniform scale)



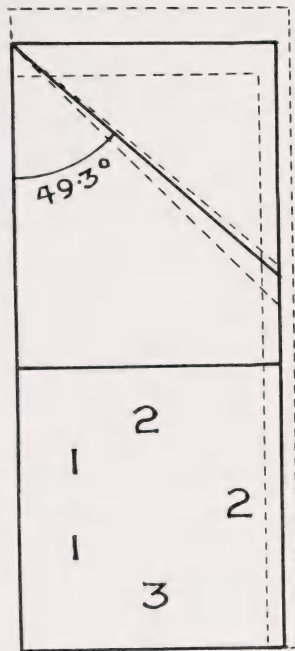
Above: From near Cape Te Reinga looking S.W. (position X on map).
 A = $\frac{1}{4}$ -mile wide deep waterway separating Cape Maria van Diemen Island from mainland. B = tombolo, site of former waterway. C = tombolo, site of second former waterway. Figures show location of subspecies: 1. *ambagiosus*; 2. *hinemoa*; 3. *consobrinus*; 4. *worthyi*; and 5. *priscus*.

Below: Map of northernmost block (adapted from Bartrum and Turner, 1928).

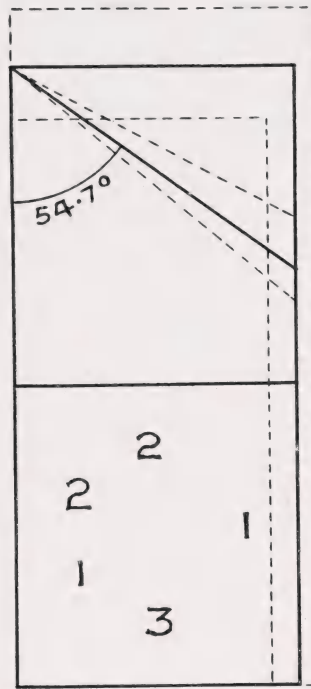




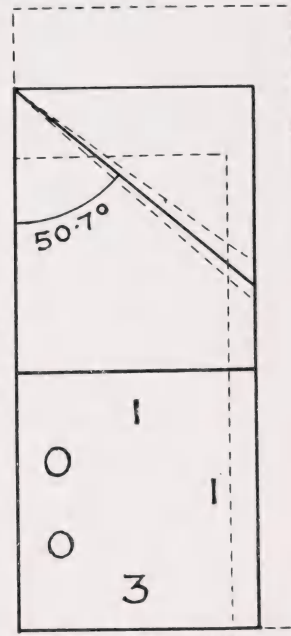
Type locality of *Placostylus ambagiosus spiritus* n. subsp. As the fossils occur in loose dunes two to three miles east of Pandora, Spirits Bay. Former stratification has been telescoped by the action of wind so that the fossil snails and the stones associated with the later period of Maori occupation are brought to a common level.



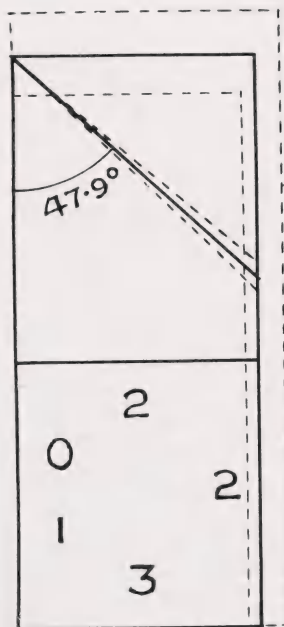
AMBAGIOSUS



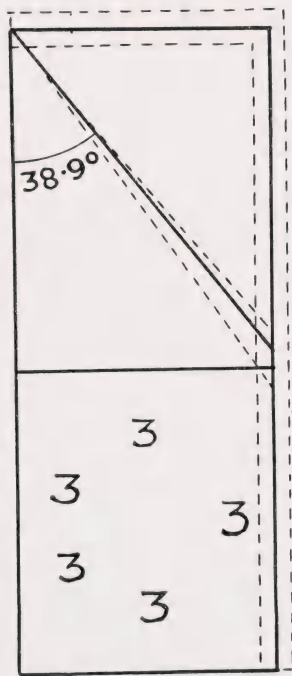
HINEMOA



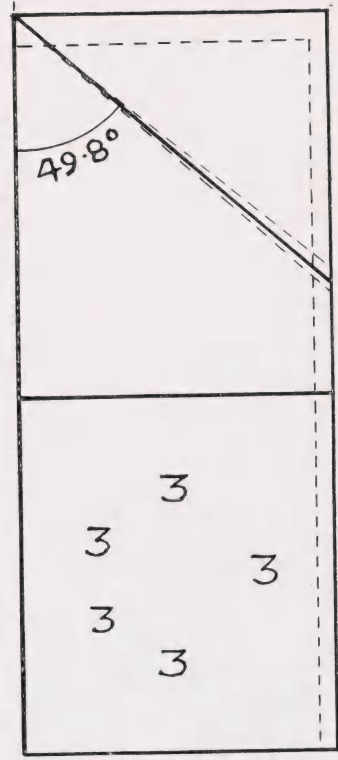
WORTHYI



SPIRITUS



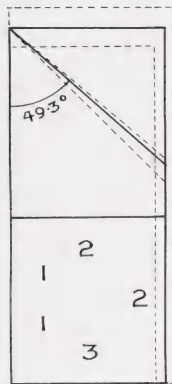
KEENORUM



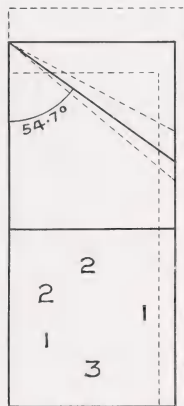
ANNECTENS

DIAGRAMMATIC KEY.

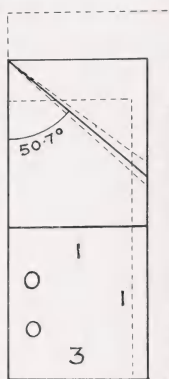
Representations of shells, all actual size. For description see page 177.



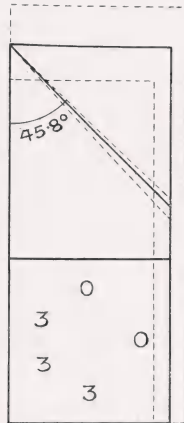
AMBAGIOSUS



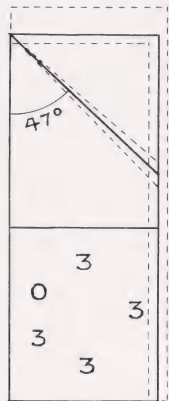
HINEMOA



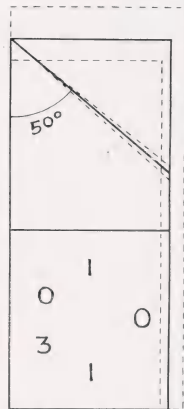
WORTHYI



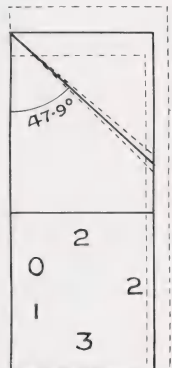
CONSOBRINUS



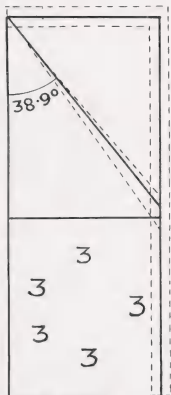
PRISCUS



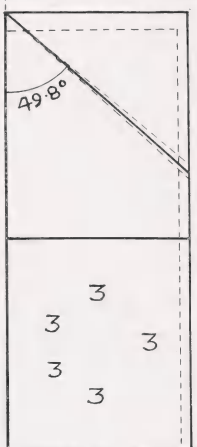
LESLEYAE



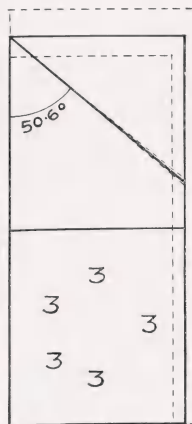
SPIRITUS



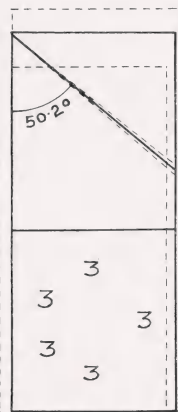
KEENORUM



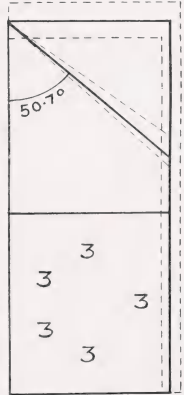
ANNECTENS



WATTI (North Cape)



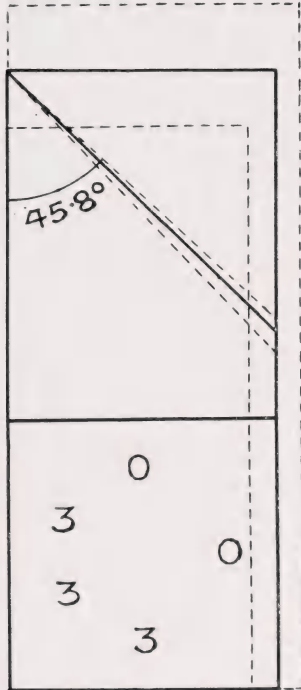
WATTI (Tom Bowling)



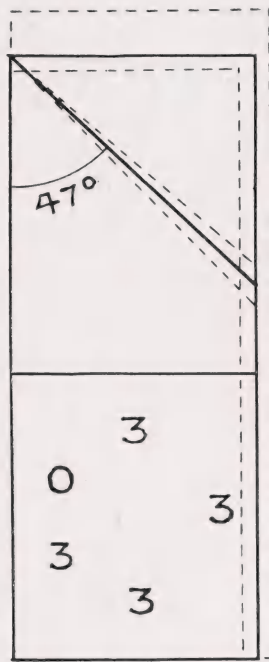
WATTI (Waikuku)

DIAGRAMMATIC KEY.

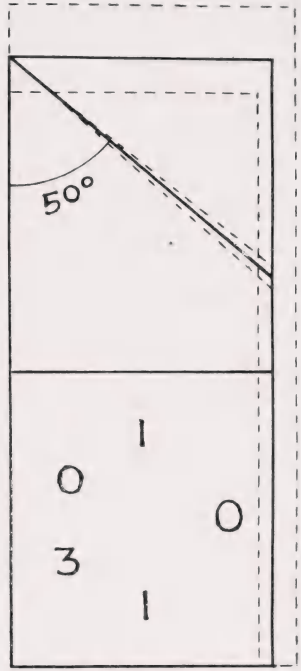
Representations of shells, all actual size. For description see page 177.



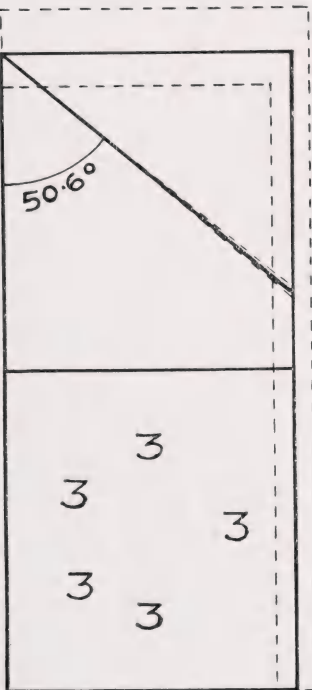
CONSOBRINUS



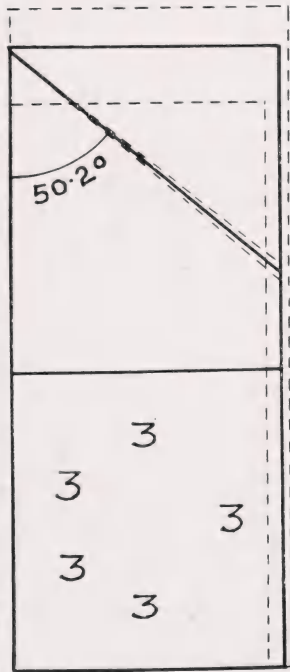
PRISCUS



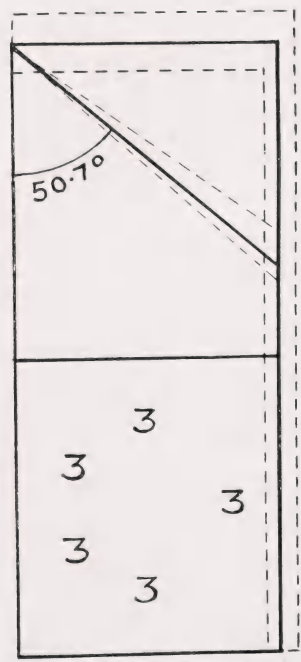
LESLEYAE



WATTI (North Cape)



WATTI (Tom Bowling)



WATTI (Waiuku)